

# Malignant Tumors of the Liver and Lungs in an Area with A PVC Industry

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The incidence of malignant tumors of the lung and bronchus and of cytologically confirmed primary malignant tumor of the liver was analyzed for a 4-yr period in a city with several factories, including a PVC industry. Prior to the study two cases of angiosarcoma of the liver were diagnosed in workers employed in PVC production.

The total incidence of analyzed tumors was only slightly higher than predicted. The tumors of the liver recorded did not show any dependence on place of work or residence. During the period of observation, malignant tumors of the bronchus (lung) were not recorded in the PVC industry. Their rate in the area in which the PVC industry is situated was approximately the same as that for the entire city area.

The study does not indicate that the occurrence of malignant tumors other than angiosarcoma is associated with exposure to vinyl chloride.

After the occurrence of angiosarcoma of the liver had been associated with exposure to vinyl chloride in a Yugoslav factory for the production and processing of PVC which started to operate in 1949, causes of death were analyzed in a group of 62 workers. The analysis was carried out at the beginning of 1975.

The data showed that two workers died of primary carcinoma of the liver, five of bronchogenic carcinoma, and eight of other malignant tumors (neoplasms of larynx, rib, breast, spermatic cord, glioma of brain, melanosis, leukemia, Hodgkin's disease).

Subsequent analysis of the biopsy material in the two workers reported to have died of the primary carcinoma of the liver in 1973 showed that both had angiosarcomas (1). This finding was the reason for examining the incidence of carcinoma in the area in which the PVC industry is located and which also houses several other industries with possible carcinogenic exposures. Two tumors were chosen for the study: malignant tumor of the lung and bronchus (162.1 WHO International Classification Code) and cytologically confirmed primary

malignant tumor of the liver (155.0 WHO International Classification Code) (2). The study concerned the incidence and some characteristic features of their appearance.

## Sample and Method

According to the 1971 census the area in which the study was performed had a total population of 185,047; 90,499 men and 94,548 women. There were 75,453 inhabitants (35,226 men and 40,227 women) aged 35 years and older. The city itself comprises 126,000 inhabitants while remaining 59,000 live in the greater city area which includes the northern industrial part of the town.

The principal industries, apart from the PVC industry, are the production of cement (including a factory of asbestos cement products), shipbuilding, and construction. These and other industries employ a total of 71,610 city inhabitants.

The incidence of malignant bronchogenic (lung) tumors and primary malignant tumors of the liver was analyzed only for a period of four years, from 1968 (when the tumor registry for malignant tumors was established) to 1971.

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From the registry data, a list of the ill was compiled and followed up. The families of those who died of malignant tumors of the lung or liver were generally interviewed, as few persons recorded as being ill were still alive at the time of the interview. The interview included questions about occupation, place of work, place of residence, smoking habits and some questions about medical history and course of the disease.

Parallel data were collected from the PVC, cement and asbestos-cement industries as well from hospitals about persons with the same malignant tumors. This information served to check up and possibly supplement data in the registry.

The incidence of bronchogenic malignant tumors and of the primary liver neoplasms was analyzed by sex, age, place of work, and place of residence.

## Results

Over the observed 4-yr period, there were 193 cases of malignant tumors of the lung and bronchus and eight microscopically verified primary malignant tumors of the liver.

For 27 persons listed in the registry as having malignant tumor of the lung (bronchus) no other information was collected, while for the rest additional data were gathered mainly by interviewing families or consulting medical records in industrial health units and hospitals.

Table 1 summarizes data on the malignant tumors of the lung and bronchus and on primary malignant tumors of the liver (1968–1971) in the area under study. Table 2 shows the number of cases and the incidence rates for the same malignant tumors and for the same period in the Republic of Croatia as listed in the Cancer Registry of SR Croatia, 1975 (3).

Of those with malignant tumors of the lung and bronchus 93% of the men and 47% of the women were smokers; 3% was in the age group 35–44, 39% in the age group 45–64, and 58% in the age group 65 and older.

In Table 3 are shown data on the incidence of the bronchogenic (lung) tumors according to place of work. The industries considered were: PVC, cement, asbestos-cement, shipbuilding, and construction, which employed 18,217 (15,332 men and 2885 women) and showed 34 cases of malignant tumors of the lung

Table 1. Malignant tumors of the lung and bronchus (162.1) and liver (155.0) in the area under study (1968–1971).

Primary site	No. of cases			Average annual incidence rates per 100,000					
				Raw rates			Age 35 and older <sup>a</sup>		
	M	F	Total	M	F	Total	M	F	Total
Lung and bronchus	158	35	193	43.7	9.3	26.1	112.1	20.5	63.3
Liver	4	4	8	1.1	1.1	1.1	2.8	2.5	2.7

<sup>a</sup> Only two cases of tumors of the lung and bronchus were found in persons under 35 years of age (females).

Table 2. Malignant tumors of the lung and bronchus (162.1) and liver (155.0) in Croatia (1968–1971).

Primary site	No. of cases			Average annual incidence rates per 100,000					
				Raw rates			Age 35 and older <sup>a</sup>		
	M	F	Total	M	F	Total	M	F	Total
Lung and bronchus	3973	651	4624	46.4	7.1	26.1	107.8	14.2	56.3
Liver	97	82	179	1.1	0.9	1.0	2.5	1.8	2.2

<sup>a</sup> Only 47 cases (31 males and 16 females) of tumor of the lung and bronchus and 4 cases (males) of tumors of the liver were found in persons under 35 years of age.

Table 3. Malignant tumors of the lung and bronchus according to place of work (1968-1971).

Industry (activities)	No. of employees (age 35 and older)		No. of cases		Average annual incidence rates per 100,000 males (age 35 and older)
	M	F	M	F	
PVC	1100	253	—	—	—
Cement	1663	278	11 <sup>a</sup>	1 <sup>b</sup>	165.4
Asbestos cement	437	122	3 <sup>c</sup>	—	171.6
Shipbuilding	2020	404	8 <sup>d</sup>	—	99.0
Construction	2400	470	11 <sup>e</sup>	—	114.6
Others	14000 <sup>a</sup>	6000 <sup>f</sup>	55	4	98.2

<sup>a</sup> All employed in direct production for 25-40 yr; only one was a nonsmoker.

<sup>b</sup> Cleaner in cement mill for 25 yr, nonsmoker.

<sup>c</sup> All employed in direct production for about 40 yr; all were smokers.

<sup>d</sup> Seven were employed in direct production for 20-35 yr; all were smokers.

<sup>e</sup> Nine were employed as construction workers for 20-40 yr; ten were smokers.

<sup>f</sup> Estimate.

Table 4. Malignant tumors of the lung and bronchus according to place of residence (1968-1971).

Place of residence	No. of inhabitants age 35 and older <sup>a</sup>		No. of cases		Average annual incidence rates per 100,000 (age 35 and older)	
	M	F	M	F	M	F
Around PVC plant	1750	2000	7	2	100.0	25.0
Around cement plants	1800	2100	8 <sup>b</sup>	—	111.1	—
Around asbestos cement plant	180	190	4 <sup>c</sup>	2	555.5	263.2
Old part of the town	6200	6600	29	5	116.9	18.9
Others	25300	29280	110	26 <sup>d</sup>	108.7	20.5

<sup>a</sup> Estimate.

<sup>b</sup> Five cement workers.

<sup>c</sup> Three asbestos cement workers.

<sup>d</sup> Two cases relate to women younger than 35 yr.

(bronchus). The 53,393 in other industries showed 59 cases of the malignant tumors of the lung and bronchus.

Data on the incidence of the malignant tumors of the lung and bronchus by place of residence are given in Table 4. The dwelling zones in the area in which the PVC industry is located, then the section with the cement industries, the area around the asbestos cement works and the old, densely populated part of the town are listed separately.

Of eight recorded cases of primary liver neoplasms none was from the neighborhood where PVC factories are located; four were in housewives and four in retired people with no specific association with the industry with respect to the place of residence or previous occupations. The age of the patients varied between 58 and 80 years.

All registered primary liver tumors were microscopically diagnosed as hepatocellular carcinomas.

## Discussion

The data presented on the incidence of malignant neoplasms of the bronchus and lung and on malignant neoplasms of the liver indicate that the total incidence in the analyzed area was only slightly higher than predicted (compared with data for Croatia for the same period).

An analysis of the incidence of these malignant neoplasms did not show any dependence on the place of work or residence as regards the primary cytologically verified malignant tumors of the liver. During the observed period, no malignant tumors of the bronchus (lung) were recorded in the PVC industry. A higher rate of these tumors was recorded in the cement and asbestos cement production. However, it should be emphasized that the great majority of cases of tumors were recorded in men who smoked. On the other hand, almost 50% of the tumors in women occurred in nonsmokers.

The distribution of tumors by place of residence within the area in which the PVC industry is situated was approximately the same as that for the entire city area.

The time of observation was certainly too short to permit firm conclusions. It was also impossible to trace a number of cases listed in the registry. The rates were calculated even if the number of cases was too small. This, of

course, must be considered in interpretation of some of the results. However, it is assumed that all this was of no great influence on the established relationships.

## Conclusions

The study of the incidence of the malignant bronchial tumors and the primary cytologically verified malignant tumors of the liver diagnosed as hepatocellular carcinomas over a 4-yr period in an area with a PVC industry does not show an association between this industry and the occurrence of tumors. The occurrence of other malignant tumors, with the exception of angiosarcoma, also seems unrelated to exposure to vinyl chloride. In the meantime, in addition to the two cases of angiosarcoma of the liver reported previously in the workers employed in the polymerization of vinyl chloride, another case of angiosarcoma was diagnosed in a polymerization worker from the same factory.

## REFERENCES

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